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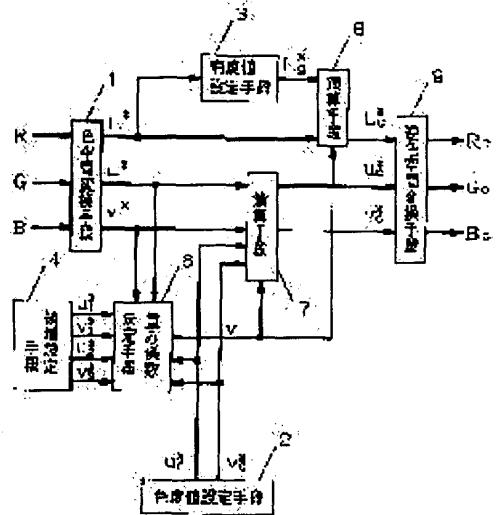
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## (54) COLOR ADJUSTMENT DEVICE

## (57)Abstract:

PURPOSE: To attain adjustment of natural color by using a chromaticity plane so as to set a hue and a saturation of a color set as a reference chromaticity to each reference value and setting the lightness to a reference lightness.

CONSTITUTION: An inputted color signal RGB is given to a color space conversion means 1, in which the signal is converted into a signal representing a uniform perception color space  $L^*U^*V^*$  in compliance with the CIE1976. A weight coefficient decision means 6 decides a weight coefficient  $V$  depending on a distance between the chromaticity values  $U^*, V^*$  of the inputted color and reference chromaticity values  $U_0^*, V_0^*$ . A chromaticity signal  $Lc^*$  subjected to color adjustment is obtained by an arithmetic operation means 7 from the signals  $U^*, V^*$  and the reference chromaticity values  $U_0^*, V_0^*$  in the output from the means 1 based on the weight coefficient  $V$  decided by the means 6. Similarly the lightness signal  $Lc^*$  subjected to color adjustment is obtained by the arithmetic operation means 8 from the signal  $L^*$  and the reference lightness  $Lg^*$  in the output of the means 1 based on the coefficient  $V$ . An inverted color space conversion means 9 converts the lightness  $L^*$  and the chromaticity values  $Uc^*, Vc^*$  into RGB signals and signals  $Rc, Gc, Bc$  subjected to color adjustment are obtained.



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## CLAIMS

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## [Claim(s)]

[Claim 1] Color tone [ which is equipped with the following and characterized by making the output of the aforementioned operation means into an output chromaticity signal ] ready equipment. A chromaticity value setting means to make the signal on the chromaticity flat surface expressed with two attributes excluding the input lightness signal and the aforementioned lightness component in the signal with which a lightness component is expressed among the three attributes of the color of the color picture signal inputted into an input chromaticity signal, and to set up a predetermined criteria chromaticity value. A field setting means to set up the field on a chromaticity flat surface including this criteria chromaticity value. A weighting-factor determination means to output the value of 0 out of the setting field of the aforementioned field setting means, and to output the value near 1, so that the distance of the chromaticity signal and the aforementioned criteria chromaticity signal which are inputted in the setting field of the aforementioned field setting means is near. An operation means to divide interiorly the aforementioned input chromaticity signal and the aforementioned criteria chromaticity signal by the output value of the aforementioned coefficient generating means.

[Claim 2] A chromaticity value setting means to make the signal on the chromaticity flat surface expressed with two attributes excluding the input lightness signal and the aforementioned lightness component in the signal with which a lightness component is expressed among the three attributes of the color of the color picture signal inputted into an input chromaticity signal, and to set up a predetermined criteria chromaticity value, A field setting means to set up the field on a chromaticity flat surface including this criteria chromaticity value, A weighting-factor determination means to output the value of 0 out of the setting field of the aforementioned field setting means, and to output the value near 1, so that the distance of the chromaticity signal and the aforementioned criteria chromaticity signal which are inputted in the setting field of the aforementioned field setting means is near, Color tone ready equipment characterized by having a lightness value setting means to set up a predetermined lightness value, and an operation means to divide interiorly the aforementioned input lightness signal and the output of the aforementioned lightness value setting means by the output value of the aforementioned coefficient generating means, and making the output of the aforementioned operation means into an output lightness signal.

[Claim 3] A lightness value setting means color tone ready equipment according to claim 2 characterized by setting up a lightness value by carrying out the gray scale conversion of the input lightness signal.

[Claim 4] Color tone ready equipment according to claim 1, 2, or 3 characterized by having a color space conversion means to change the color picture signal inputted into a luminance signal and a color-difference signal, and making a color-difference signal into a chromaticity signal.

[Claim 5] Color tone ready equipment according to claim 1, 2, 3, or 4 characterized by providing the following. A weighting-factor determination means is a chromaticity-coordinate conversion means to change an input chromaticity signal into the system of coordinates which make a zero a criteria chromaticity value. A coefficient generating means to generate the weighting factor which outputs the value of 1 at the zero in the new chromaticity coordinate changed by this chromaticity-coordinate conversion means, decreases continuously according to the distance from a zero, and is set to 0 in the boundary section of the setting field of a field setting means.

[Claim 6] The field which a field setting means sets up on a chromaticity flat surface is a rectangle. a weighting-factor determination means Two axes of coordinates of the aforementioned chromaticity flat surface are equipped with a fuzzy AND-operation means to generate a weighting factor by the fuzzy AND of the output of two coefficient generating means to generate an parallel weight component respectively. The aforementioned coefficient generating means is color tone ready equipment according to claim 1, 2, 3, or 4 characterized by decreasing continuously as the weighting factor to which a criteria chromaticity value corresponds outputs and leaves the value of 1, and generating the weighting factor which is 0 on the boundary of the setting field of a field determination means.

[Translation done.]

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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

#### [0001]

[Industrial Application] this invention relates to the automatic color tone ready equipment which can be automatically changed to the color of a request of only the color of the specific range, saving other colors within a picture in the device which deals with color pictures, such as a color printer, a color copying machine, and a color TV.

#### [0002]

[Description of the Prior Art] In recent years, color adjustment which can meet the demand based on a user's sensibility is desired with high-definition-izing of various color picture devices, and intelligent-izing.

[0003] The concrete content of adjustment required of color adjustment from the former is various. Advanced things, such as the hue and saturation only to the color contained to the thing using positional information and the specific color field of a picture, and adjustment of a luminosity, are also contained like color conversion of only the portion in the specific position in a picture from simple things, such as adjustment of the luminosity of the whole picture, adjustment of the thickness of a color, and RGB, adjustment of the color balance of CMY.

[0004] It will be thought that a demand decreases, if it is a thing aiming at the dissatisfied dissolution which a user mainly has to an output picture, the performance of these color picture devices is usually improved and these adjustments can perform a sufficiently faithful color reproduction.

[0005] However, there is a thing based on the mental demand which human being has apart from the performance of equipment among the dissatisfaction over the above-mentioned quality of image. Generally there are some which are called "desirable color reproduction" to "a faithful color reproduction", and a "memory color" is the representation. For example, a color which says mentally "it must be such a color" or "I want you to be" to how [ green ] of flesh color or trees is called memory color.

[0006] Especially, with hard copy equipments, such as a video printer, in order that only hard copy may remain independently behind with a subject copy, it becomes important to reproduce the color more desirable than reproducing a color faithful to a subject copy for those who see. This is more remarkable to a memory color, flesh color is very important also including liking especially, there is no flesh color faithful to a photographic subject in many cases rarely [ good ], and it has become the cause as which the color adjustment to a memory color is required.

[0007] If it is the hard copy of the television broadcasting currently photoed in studio, since a performer makes up his face and a photograph is actually taken under the light source of sufficient quantity of light, flesh color usually desirable also for a televiwer is reproduced in many cases.

[0008] However, that the desirable flesh color near storage is reproduced has, few other broadcast, for example, one scene of a drama etc., etc. Furthermore, since there is also no makeup of a photographic subject, lighting also has little quantity of light, or many shadows are in a face only by the natural light, a white balance is also auto and what the amateur photoed on the movie (camcorder/movie) is influenced by the color of a background, it is very difficult for the desirable flesh color of a memory color being reproduced.

[0009] On the other hand, in the conventional color adjustment, if television is mentioned as an example, in case it will recover from NTSC to RGB, the composition which can perform color adjustment by adjusting the phase and level of a chroma and adjusting offset of brightness is taken. A hue specifically rotates by changing the phase of a chroma, and saturation can be adjusted by changing the level of a chroma. Moreover, change of offset of brightness is outline \*\*\*\* as lightness adjustment. In order that this preparation may adjust sexual desire news with three attributes according to the three attributes of lightness, a hue, and saturation which are easy to understand sensuously for human being, comparatively [ easy ] it is easy to treat it, and it is excellent in it.

[0010] Moreover, although an equipment scale is large, the alternative color tone ready equipment in which color adjustment is possible is also proposed to the specific color field by changing an input signal into a color space with the

three attributes of lightness, a hue, and saturation, performing rotation and saturation adjustment of the hue of only a specific color on the color space, and transforming the result inversely to the original color space (the "Institute of Image Electronics Engineers of Japan" of volume [ 18th ] 5 No. 302-312 pages).

[0011]

[Problem(s) to be Solved by the Invention] However, with the above conventional color tone ready equipments, the technical problem that the color adjustment to a memory color is difficult, and it is still more difficult to adjust to a memory color automatically occurs.

[0012] For example, by the color tone ready method used on television, if flesh color is mentioned as an example as a memory color, since it cannot pass over hue adjustment for all colors to be rotated simultaneously and it cannot make saturation adjustment and lightness adjustment act uniformly to a full screen, either, it cannot bring only flesh color close to a desirable color, without affecting other colors.

[0013] Moreover, conventional alternative color tone ready equipment performs rotation of a hue, and adjustment of saturation only to the specific color field in a color space, and if other colors and separation are possible for the color field containing the inputted flesh color, it will not affect any colors other than the color field. However, with the beige hue and beige saturation as which it was inputted [ desirable ] whether it becomes beige when rotating the hue in which direction for the flesh color of an input signal and adjusting saturation how in the color field, since it is various, the judgment needs to carry out, and human being needs to direct.

[0014] Furthermore, since various flesh colors are actually contained also in one face picture, it is very rare that all the inputted flesh colors are displacing a hue, saturation, and lightness by the same degree as the same direction to the flesh color of a memory color. Usually, since it is displacing by various directions and degrees to the flesh color of a memory color, though the field where flesh color is contained with conventional alternative color tone ready equipment is able to be pinpointed, no flesh colors in an input picture can be brought close to a memory color.

[0015] As mentioned above, by the conventional technique, the technical problem that the adjustment to a memory color is very difficult, and it is still more difficult to be automatic and to perform it occurs.

[0016] In view of the above-mentioned technical problem, according to the direction and degree of a variation rate from a memory color, this invention determines the amendment direction automatically, for the purpose of offer of the color tone ready equipment which can be brought close to the flesh color of a memory color automatically, is easy circuitry and offers the color tone ready equipment in which the high-speed processing which can be processed on real time to a video signal is possible to all the flesh colors in a picture. Moreover, naturally it is applicable also like memory colors other than flesh color.

[0017]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem the color tone ready equipment of this invention A chromaticity value setting means to make the signal on the chromaticity flat surface expressed with two attributes excluding the input lightness signal and the aforementioned lightness component in the signal with which a lightness component is expressed among the three attributes of the color of the color picture signal inputted into an input chromaticity signal, and to set up a predetermined criteria chromaticity value, A field setting means to set up the field on a chromaticity flat surface including this criteria chromaticity value, A weighting-factor determination means to output the value of 0 out of the setting field of the aforementioned field setting means, and to output the value near 1, so that the distance of the chromaticity signal and the aforementioned criteria chromaticity signal which are inputted in the setting field of the aforementioned field setting means is near, A chromaticity value setting means to have an operation means to divide interiorly the aforementioned input chromaticity signal and the aforementioned criteria chromaticity signal by the output value of the aforementioned weighting-factor determination means, and to set up a further predetermined criteria chromaticity value, A field setting means to set up the field on a chromaticity flat surface including this criteria chromaticity value, A weighting-factor determination means to output the value of 0 out of the setting field of the aforementioned field setting means, and to output the value near 1, so that the distance of the chromaticity signal and the aforementioned criteria chromaticity signal which are inputted in the setting field of the aforementioned field setting means is near, It has a lightness value setting means to set up a predetermined lightness value, and an operation means to divide interiorly the aforementioned input lightness signal and the output of the aforementioned lightness value setting means by the output value of the aforementioned weighting-factor determination means.

[0018]

[Function] As opposed to the input chromaticity signal on the chromaticity flat surface expressed with two attributes except the lightness component among the three attributes of the color of the color picture signal inputted by the composition which described this invention above The distance on the chromaticity flat surface of the criteria chromaticity value of a memory color and input chromaticity signal which the chromaticity value setting means set up

is embraced. By a weighting-factor determination means' determining a weighting factor, determining the chromaticity value on the straight line which connects the coordinate of an input chromaticity signal, and the coordinate of a criteria chromaticity value according to the weighting factor, and considering as an output chromaticity value It amends by determining that a hue, the amendment direction of saturation, and a degree will always bring an input chromaticity value close to a criteria chromaticity value.

[0019] Moreover, according to the distance on the chromaticity flat surface of the criteria chromaticity value of a memory color and input chromaticity signal which the chromaticity value setting means set up, a weighting-factor determination means determines a weighting factor to an input lightness signal and an input chromaticity signal, the lightness value on the straight line which connects the value of an input lightness chromaticity signal and the criteria lightness value which a lightness value setting means outputs is determined according to the weighting factor, and it considers as an output lightness signal.

[0020] Even if the input chromaticity signal is displacing in which direction to a criteria chromaticity value, it has the operation effect that it can bring near by the criteria chromaticity value and the criteria lightness value correctly automatically, and since the degree to bring near can be freely determined with a weighting-factor determination means, the above operation enables it to draw in a memory color in a natural form.

[0021]

[Example] The color tone ready equipment of the 1st example of this invention is explained below, referring to a drawing.

[0022] Before performing explanation of operation, the chromaticity signal showing two elements on the chromaticity flat surface which expresses a hue component and a saturation component among the three attributes of the color stated by this invention is explained.

[0023] As a chromaticity signal which expresses the flat surface showing a hue component and a saturation component with a rectangular coordinate system The color-difference signal of brightness color-difference signals (for example, Y, R-Y, B-Y signal and Y, U, V signal, etc.), HS signal of the chroma signal of a brightness chroma signal (YC signal), the degree index of perceived color ( $u^*v^*$ ) of a CIE1976 equal perceived color space ( $L^*u^*v^*$ ), the degree index of perceived color ( $a^*b^*$ ) of a CIE1976 equal perceived color space ( $L^*a^*b^*$ ), and HLS space etc. is mentioned. In this invention, a signal with the two attributes of such hues and saturation is called chromaticity signal.

[0024] Drawing 1 is the block diagram showing the outline composition of the color tone ready equipment in the 1st example of this invention. It is a color space (it is a color space conversion means to change into the signal ( $L^*$ ,  $u^*$ ,  $v^*$ ) which expresses the coordinate on a CIE1976 equal perceived color space ( $L^*u^*v^*$ ) with this example.) about the chrominance signal (in this example, it considers as an RGB code) into which 1 was inputted in drawing 1. A chromaticity value setting means to set up the chromaticity signal ( $u_0^*$ ,  $v_0^*$ ) showing the chromaticity coordinate of a criteria color with which 2 is equivalent to a memory color, a lightness value setting means by which 3 sets up the reference value ( $L_g^*$ ) of the lightness of a criteria color similarly, and 4 are field setting meanses to set up the color tone ready field containing an attention color.

[0025] In the color tone ready field set up with the field setting means 4 according to the chromaticity signal ( $u^*$ ,  $v^*$ ) inputted, 6 a weighting-factor determination means to determine weighting-factor  $w$  which shows the degree of adjustment number of a color, and 7 -- the chromaticity signal of the outputs of the color space conversion means 1 ( $u^*$  --) An operation means to output the chromaticity signal by which color adjustment was carried out based on weighting-factor  $w$  determined with the weighting-factor determination means 6 from  $v^*$  and the output chromaticity signal ( $u_0^*$ ,  $v_0^*$ ) of the chromaticity value setting means 2, An operation means to output the lightness signal with which 8 performed color adjustment based on weighting-factor  $w$  determined with the weighting-factor determination means 6 from the lightness signal of the outputs of the color space conversion means 1 ( $L^*$ ), and the output ( $L_g^*$ ) of the lightness value setting means 3, 9 is a reverse color space conversion means to change the output chromaticity signal ( $u_c^*$ ,  $v_c^*$ ) of the operation means 7, and the output lightness signal ( $L_c^*$ ) of the operation means 8 into an RGB code.

[0026] Moreover, drawing 2 is the block diagram of the outline composition of the weighting-factor determination means 6. 61 is a chromaticity-coordinate conversion means to perform coordinate transformation so that the chromaticity coordinate of a criteria color may become a zero about the chromaticity flat surface on equal color perception space, and it carries out vector subtraction of the criteria chromaticity coordinate ( $u_0^*$ ,  $v_0^*$ ) from the chromaticity signal ( $u^*$ ,  $v^*$ ) specifically inputted. Similarly 62 is a color tone ready field coordinate transformation means to perform coordinate transformation to the color tone ready field ( $u_1^*$ ,  $u_2^*$ ,  $v_1^*$ ,  $v_2^*$ ) which the field setting means 4 set up. 63 is a coefficient generating means to generate weighting-factor  $w$  from the chromaticity signal ( $u^*$  -  $u_0^*$ ,  $v^*$  -  $v_0^*$ ) of the output of the chromaticity-coordinate conversion means 61, and the new color tone ready field ( $u_1^* - u_0^*$ ,  $u_2^* - u_0^*$ ,  $v_1^* - v_0^*$ ,  $v_2^* - v_0^*$ ) changed with the color tone ready field coordinate transformation means 62.

[0027] Furthermore, drawing 3 is explanatory drawing of the chromaticity-coordinate conversion means 61 and the color tone ready field coordinate transformation means 62 of operation. Coordinate transformation is performed so that the chromaticity signal ( $u0^*$ ,  $v0^*$ ) which expresses a criteria chromaticity value as shown in drawing 3 may serve as a zero. In addition, the field of the rectangle which the slash section of the rectangle shown in drawing 3 (a) shows the color tone ready field set up with the field setting means 4, and is shown in drawing 3 (b) is a color tone ready field changed with the color tone ready field coordinate transformation means 62.

[0028] Drawing 4 is illustrated on the coordinate into which weighting-factor  $w$  which the coefficient generating means 63 generates is changed with the chromaticity-coordinate conversion means 61. As shown in drawing, weighting-factor  $w$  is the maximum ( $w=1$ ), when the chromaticity signal ( $u^*$ ,  $v^*$ ) inputted into the chromaticity-coordinate conversion means 61 is in agreement with a zero ( $u0^*$ ,  $v0^*$ ), i.e., a criteria chromaticity value, on the changed coordinate, it becomes small continuously as it is left to the boundary of a field, and it is set up on a boundary so that weighting-factor  $w$  may be set to 0. Moreover, the outside of a boundary is 0 uniformly. In this example, since it is easy, it is considering as the linear distribution.

[0029] Drawing 5 is the block diagram showing the composition of the operation means 7 and the operation means 8. 74, a reversal means by which 84 outputs the one's complement of weighting-factor  $w$ , 71-a, The multiplier with which 71-b carries out the multiplication of the criteria chromaticity value ( $u0^*$ ,  $v0^*$ ) of a chromaticity value setting means, and the weighting-factor  $w$  respectively, The multiplier with which 81 carries out the multiplication of the criteria lightness value ( $Lg^*$ ) of a lightness value setting means, and the weighting-factor  $w$  respectively, The multiplier with which 72-a and 72-b carry out the multiplication of the chromaticity signal ( $u^*$ ,  $v^*$ ) of the output of the color space conversion means 1, and the complement  $1-w$  of a weighting factor respectively, The multiplier with which 82 carries out the multiplication of the lightness signal ( $L^*$ ) of the output of the color space conversion means 1, and the complement  $1-w$  of a weighting factor, The adder with which 73-a adds the output of multiplier 71-a and the output of multiplier 72-a, the adder with which 73-b adds the output of multiplier 71-b and the output of multiplier 72-b, and 83 are the adders adding the output of a multiplier 81, and the output of a multiplier 82.

[0030] Therefore, the operation means 7 will divide interiorly the chromaticity signal of the outputs of the color space conversion means 1 ( $u^*$ ,  $v^*$ ), and a criteria chromaticity value ( $u0^*$ ,  $v0^*$ ) by weighting-factor  $w$ . Similarly, the operation means 8 will divide interiorly the lightness signal of the outputs of the color space conversion means 1 ( $L^*$ ), and a criteria lightness value ( $Lg^*$ ) by weighting-factor  $w$ . If this operation is expressed with a formula, a formula (1), (2), and (3) can show.

[0031]

$$uc^* = (1-w) -u^* + w-u0^* \dots (1)$$

$$vc^* = (1-w) -v^* + w-v0^* \dots (2)$$

$$Lc^* = (1-w) -L^* + w-Lg^* \dots (3)$$

Moreover, drawing 6 is a graph showing the input-output behavioral characteristics of the lightness value setting means 3.

[0032] The chromaticity value showing the hue and saturation of a memory color has set up the semipermanent value ( $u0^*$ ,  $v0^*$ ) by the chromaticity value setting means. Although there are a reference value of the lightness of a memory color and the method of making it into a fixed value ( $L0^*$ ), in order to acquire a more natural picture, by this example, it is considering as the function of a lightness input as shown in drawing.

[0033] In an input color, also by the color which a hue and saturation can judge to be a predetermined memory color, the purpose avoids unnatural big amendment to lightness, when lightness differs from a memory color greatly.

[0034] Hereafter, operation of the 1st example of this invention is explained using drawing 6 from drawing 1.

[0035] First, the inputted chrominance signal RGB is changed into the signal showing a CIE1976 equal perceived color space ( $L^*u^*v^*$ ) by the color space conversion means 1. This conversion is expressed in two stages and shows a formula (4), (5) and (6), and the 2nd step to a formula (7), (8), and (9) for the 1st step.

[0036]

$$X = 0.607, R+0.173, G+0.200, \text{ and } B \dots (4)$$

$$Y = 0.299, R+0.586, G+0.115, \text{ and } B \dots (5)$$

$$Z = 0.066, G+1.116, \text{ and } B \dots (6)$$

$$L^* = 116x(Y/Y0) (1/3)-16 \dots (7)$$

$$u^* = 13xL^*x (u-u0) \dots (8)$$

$$v^* = 13xL^*x (v-v0) \dots (9)$$

however  $u = 4X/(X+15Y+3Z)$   $v = In a 0 = 1$ ,  $u0=0.20089$ , and  $v0=0.30726$  CIE1976 equal perceived-color-space ( $L^*u^*v^*$ ) top  $6Y/(X+15Y+3Z)$   $Y$  -- By the polar coordinate, since a hue component and a saturation component are expressed, the chromaticity value on the chromaticity flat surface except lightness ( $u^*$ ,  $v^*$ ) can be adjusted, with a

luminosity maintained, if color adjustment is performed within this flat surface. Drawing 7 is drawing explaining the concept of the conventional color correction performed on a chromaticity flat surface. If the chromaticity ( $u^*$ ,  $v^*$ ) of a certain color is changed into a polar coordinate and only an angle theta is rotated, a hue will rotate, and if the distance from a zero is doubled k, saturation will increase k times.

[0037] Next, the field setting means 4 is explained. In this example, in order to simplify circuitry, the configuration of the field which the field determination means 4 sets up is made into the configuration of a rectangle parallel to u shaft and v shaft including the criteria chromaticity, as shown in drawing 4. A field configuration can also be made arbitrary configurations according to the distribution in the chromaticity flat surface of the color equivalent to a desired memory color.

[0038] The weighting-factor determination means 6 determines weighting-factor w according to the distance of the chromaticity value ( $u^*$ ,  $v^*$ ) of a color and criteria chromaticity value ( $u0^*$ ,  $v0^*$ ) which are inputted, and explains it to a detail further using drawing 2, drawing 3, and drawing 4 about operation of this weighting-factor determination means 3.

[0039] As shown in drawing 3, coordinate transformation is performed so that the chromaticity signal ( $u0^*$ ,  $v0^*$ ) which expresses the chromaticity coordinate of an attention color first may serve as a zero by the chromaticity-coordinate conversion means 61 in the chromaticity signal ( $u^*$ ,  $v^*$ ) inputted into the weighting-factor determination means 6.

[0040] and the color tone ready field ( $u1^*$ ,  $u2^*$ , and  $v1^*$  --) set up with the field setting means 4 It asks for the input-output behavioral characteristics of the coefficient generating means 63 based on the color tone ready field ( $u1^*-u0^*$ ,  $u2^*-u0^*$ ,  $v1^*-v0^*$ ,  $v2^*-v0^*$ ) (field of the slash shown in drawing 4) which transformed  $v2^*$  with the color tone ready field coordinate transformation means 62. It decreases continuously as this weighting-factor w is the maximum (w= 1) when a zero, i.e., the chromaticity signal inputted, is an attention color on the flat surface by which coordinate transformation was carried out, as shown in drawing 4, and it approaches the boundary of a field, and it is set up so that it may become the minimum (w= 0) on a boundary. This coefficient generating means 63 can be easily constituted, if constituted from a look-up table.

[0041] Thus, the chromaticity signal ( $uc^*$ ,  $vc^*$ ) color adjustment was carried out [ the chromaticity signal ] by the operation shown in a formula (1), (2), and (3), i.e., an interior division operation, is obtained from the chromaticity signal of the outputs of the color space conversion means 1 ( $u^*$ ,  $v^*$ ), and a criteria chromaticity value ( $u0^*$ ,  $v0^*$ ) by the operation means 7 by weighting-factor w determined by the weighting-factor determination means 6.

[0042] Similarly, the lightness signal ( $Lc^*$ ) color adjustment was carried out [ the signal ] by the same interior division operation is acquired from the lightness signal of the outputs of the color space conversion means 1 ( $L^*$ ), and a criteria lightness value ( $Lg^*$ ) by weighting-factor w by the operation means 8.

[0043] The example which actually performed the color tone ready operation of this invention described above is shown in drawing 8. It is a thing when the input-output behavioral characteristics of the coefficient generating means 63 shall show this example by drawing 4, and the function of drawing 6 has determined the criteria lightness value.

[0044] However, since drawing 8 is a chromaticity flat surface, only change of a hue and saturation is expressed and lightness change cannot be seen.

[0045] x mark in drawing expresses the criteria chromaticity value, and expresses the black dot and color tone ready backward chromaticity value with a circle [ white ] for the chromaticity value inputted from the color space conversion means 1. The color tone ready backward chromaticity coordinate is carrying out change which is drawn in a criteria chromaticity value in a natural form so that it may understand also from this drawing. As a feature of change, when - input is in agreement with a criteria chromaticity value, it does not change.

[0046] - As for the color outside a setting field, an input does not change.

- As for the size of change, near the middle of the boundary of a criteria chromaticity value and a setting field is the largest.

[0047] - The chromaticity value changes of the area within preset value are [ no ] continuation, and produce an inversion.

Therefore, while many colors in a setting field are drawn in the criteria chromaticity value which is a memory color automatically, an unnatural color change can be prevented.

[0048] Although the property of the coefficient generating means 63 is the configuration of the shape of an easy straight line, the reason such an outstanding adjustment result is obtained is because color adjustment of this invention is based on an interior division operation. Because, a weighting factor is alignment-like to the distance of an input chromaticity value and a criteria chromaticity value, and, similarly an interior division operation is alignment to distance. Since an amendment chromaticity value furthermore changes by both product, chromaticity change is because it becomes a secondary function and becomes parabola-change. It is the graph with which drawing 9 made the

horizontal axis the horizontal distance of an input chromaticity value and a criteria chromaticity value, and made the vertical axis the horizontal distance of an output chromaticity value and a criteria chromaticity value. a and b in drawing are the horizontal distance of the boundary of a setting field, and a criteria chromaticity value. The configuration which combined two parabolas focusing on the zero is carried out so that this graph may show. The outside of a zero, a, and b is changeless, and it is the property automatically drawn in a zero, and the color of the both sides of a near [ a zero ] does not have the inversion of a hue and saturation change, either, and has become a smooth continuous change. Moreover, as for the size [ chromaticity / original / (dotted line) ] of change, near the middle of a zero and a setting field becomes the largest.

[0049] It draws in a zero and condition can be freely adjusted by changing the property of the weighting-factor determination means 6.

[0050] Drawing 10 is a graph showing the property of a lightness output ( $Lc^*$ ) over a lightness input ( $L^*$ ). The change of input-output behavioral characteristics to lightness when the above-mentioned weighting-factor w changes with input chromaticity values is illustrated.

[0051] Since w becomes the property which was in agreement with the criteria lightness output shown in drawing 6 in being close to 1 when an input chromaticity is close to a criteria chromaticity namely, the input-output behavioral characteristics of lightness turn into the property that an input lightness value draws the lightness near the lightness value ( $L0^*$ ) of a memory color in a compulsive target at ( $L0^*$ ). Moreover, when an input chromaticity separates with a criteria chromaticity, amendment of as opposed to [ when close to 0 ] lightness in w will be performed.

[0052] For this reason, when a memory color is made beige and it is judged as the range with a beige chromaticity value for example, the operation which also draws lightness in desirable beige lightness is carried out, and, in the case of the other color, there is an operation which does not produce lightness change.

[0053] In addition, at this example, although the color space conversion means 1 shall be changed into a CIE1976 equal perceived color space ( $L^*u^*v^*$ ) from a chrominance signal, the same effect can be acquired with composition with the same said also of what the point changes into a CIE1976 equal perceived color space ( $L^*a^*b^*$ ) from a chrominance signal as stated and the thing which performs conversion of a brightness color-difference signal (for example, Y, R-Y, B-Y signal and a YUV signal) etc. The interconversion from RGB or NTSC is very easy for especially a brightness color-difference signal, and its practical use value is high.

[0054] Moreover, although weighting-factor w was generated in this example since the chromaticity-coordinate conversion means 61 and the color tone ready field coordinate transformation means 62 are formed in the weighting-factor determination means 6 and the criteria chromaticity value was moved to the zero, it is also possible to generate a weighting factor on a direct chromaticity flat surface, without performing coordinate transformation.

[0055] As stated above, within the chromaticity flat surface which shows a hue component and a saturation component As opposed to the input chromaticity value in a setting field including the criteria chromaticity value set up by the chromaticity value signal setting means, and this criteria chromaticity value By a weighting-factor determination means' determining a weighting factor, and determining an output chromaticity value according to a weighting factor according to the difference of an input chromaticity value and a criteria chromaticity value, from an input chromaticity value and a criteria chromaticity value Without reversing a color in the outside of a color tone ready field, and inside, with a continuity saved, natural color adjustment can be performed and it becomes possible to draw in the color nature near [ arbitrary ] a memory color at a memory color.

[0056] Moreover, since a chromaticity flat surface is not changed into a polar coordinate but it can process with rectangular coordinates, the nonlinear conversion to a complicated spherical coordinate system can constitute easily [ eye an unnecessary hatchet and an emergency ], and can make a circuit scale small.

[0057] It becomes unnecessary to perform the thing which expresses with a brightness color-difference signal the color space changed especially by the color space conversion means, then a nonlinear operation, and it is small and can consider as the composition which can moreover be processed on real time.

[0058] The 2nd example of this invention is described. As composition of the 2nd example, it is the same as drawing 1, and is constituted, and only the composition of the weighting-factor determination means 6 differs. The composition of the weighting-factor determination means 6 of this example is shown in drawing 11. In this example, since the composition and its operation of those other than weighting-factor determination means 6 are the same, detailed explanation is omitted and explains only the composition and its operation of the weighting-factor determination means 6.

[0059] Drawing 12 is explanatory drawing of the weighting-factor determination means 6 of this example of operation. the chromaticity signal ( $u0^* --$ ) to which 61 expresses the chromaticity coordinate of an attention color among chromaticity signals ( $u^*, v^*$ ) in drawing 11 A chromaticity-coordinate conversion means to perform coordinate transformation so that  $v0^*$  may become a zero on a chromaticity coordinate, and 62 are color tone ready field

coordinate transformation means to perform coordinate transformation for the color tone ready field ( $u1^*$ ,  $u2^*$ ,  $v1^*$ ,  $v2^*$ ) set up with the field setting means 4 similarly. the color tone ready field ( $u1^*-u0^* --$ ) which 93 considered output  $u^*-u0^*$  of the chromaticity-coordinate conversion means 61 as the input, and was changed with the color tone ready field coordinate transformation means 62 The 1st coefficient generating means which outputs the weighting factor  $wa$  shown in drawing 12 (a) based on  $u2^*-u0^*$ , the color tone ready field ( $v1^*-v0^* --$ ) which 94 considered output  $v^*-v0^*$  of the chromaticity-coordinate conversion means 61 as the input, and was changed with the color tone ready field coordinate transformation means 62 The 2nd coefficient generating means which outputs the weighting factor  $wb$  shown in drawing 12 (b) based on  $v2^*-v0^*$ , 65 is a fuzzy AND-operation means to output weighting-factor  $w$  which takes the fuzzy AND by the min operation shown in the formula (10) from each weighting factors  $wa$  and  $wb$  of the 1st and 2nd coefficient generating means 93 and 94 to output, and is shown in drawing 12 (c).

[0060]

$w = \min(wa \text{ and } wb) \dots (10)$

Thus, operation of the constituted this example is explained. Since its operation is the same as the 1st example, it explains briefly focusing on the weighting-factor determination means 6.

[0061] Coordinate transformation is performed so that the chromaticity signal ( $u0^*$ ,  $v0^*$ ) of an attention color may serve as a zero first by the chromaticity-coordinate conversion means 61 in the chromaticity signal ( $u^*$ ,  $v^*$ ) inputted into the weighting-factor determination means 6. the color tone ready field ( $u1^*$ ,  $u2^*$ , and  $v1^* --$ ) set up with the field setting means 4 the color tone ready field ( $u1^*-u0^* --$ ) into which  $v2^*$  was changed with the color tone ready field coordinate transformation means 62 Based on  $u2^*-u0^*$ ,  $v1^*-v0^*$ , and  $v2^*-v0^*$ , the weighting factor  $wa$  of a single dimension as considered output  $u^*-u0^*$  of the chromaticity-coordinate conversion means 61 as an input, for example, shown in drawing 12 (a) is outputted with the 1st coefficient generating means 93. Similarly, with the 2nd coefficient generating means 94, output  $v^*-v0^*$  of the chromaticity-coordinate conversion means 61 is considered as an input, and the weighting factor  $wb$  of a single dimension as shown in drawing 12 (b) is outputted. And from the weighting factors  $wa$  and  $wb$  of the single dimension generated to each input signal  $u^*-u0^*$  and  $v^*-v0^*$ , the fuzzy AND by the min operation by the fuzzy AND-operation means 65 is taken, and 2-dimensional weighting-factor  $w$  shown in drawing 12 (c) is outputted.

[0062] Then, using this weighting factor, like the 1st example, color adjustment to lightness and a chromaticity can be performed, and the signal by which the reverse color space conversion means 8 changed lightness  $L^*$  and the chromaticity ( $uc^*$ ,  $vc^*$ ) into RGB, and color adjustment was carried out in the result can be acquired.

[0063] As stated above, it is related with each element shaft of the chromaticity signal expressed with two elements of the plane rectangular coordinate system showing the hue component into which a coefficient generating means is inputted, and a saturation component. the weighting factor on a shaft by 1 Two weighting-factor determination means to generate the weighting factor which is 0 on a boundary parallel to each shaft of the color tone ready field which decrease in number continuously as it separates from a shaft, and is determined with the aforementioned color tone ready field determination means, By constituting from a fuzzy AND-operation means to generate a weighting factor by the fuzzy AND of each output of this two weighting-factor determination means The input-output behavioral characteristics of a weighting-factor determination means can be constituted from one dimension, and, also as for a fuzzy AND-operation means, composition has eye an easy hatchet and the effect that input-output behavioral characteristics can be determined more easily.

[0064] Moreover, although the chromaticity value setting means explained by this example as what sets up the chromaticity value of the desirable fixation to a memory color in order to simplify explanation, it can also be made to change according to some signals. For example, since a desirable beige chromaticity value changes with lightness a little in many cases, if a criteria chromaticity value is changed according to a lightness signal, it is possible to raise the amendment performance of the automatic color adjustment to a memory color.

[0065] Moreover, in this example, although the criteria lightness value explained what changes as a function of a lightness signal, in order that it may simplify equipment, it is also possible to make it fixation.

[0066]

[Effect of the Invention] As stated above, in the chromaticity flat surface which expresses a hue component and a saturation component among the three attributes of a color, change of what does not give this invention to colors other than a desired color field, either, but it becomes possible to give color adjustment only to a desired color.

[0067] Color adjustment of this invention can be automatically drawn in the flesh color of the memory color of a request of the inputted flesh color, for example by [ which set up as a criteria chromaticity value ] drawing a hue and saturation in a criteria chromaticity value automatically, for example to colors, such as a memory color, using a chromaticity flat surface, and drawing in a criteria lightness value automatically also about lightness. Moreover, the continuity of a color is saved, and the inversion of a color does not take place, either, but this color adjustment can

perform natural color adjustment.

[0068] Therefore, even when it is a subject copy, hard copy equipments, such as a video printer with which only hard copy remains independently behind, or the amateur photography makeup does not have whose photographic subject, either and he does not use special lighting in many cases to memory colors, such as very important flesh color, including liking, either, an automatic regulation will be carried out to the flesh color of "it being such a color" or "wanting you to be", and "a desirable color reproduction" can be realized.

[0069] Moreover, since the composition of this invention processes a chromaticity value with rectangular coordinates, complicated nonlinear transform processing to a spherical coordinate system becomes unnecessary, and it can be realized with the very easy small composition of a circuit scale.

[0070] And it becomes unnecessary to perform the thing which expresses with a brightness color-difference signal the color space changed especially by the color space conversion means, then a nonlinear operation, and it is small-scale composition and can consider as the composition which can moreover be processed on real time.

[0071] Moreover, if the composition which generates the weighting factor by the fuzzy AND is used, since a big ROM table becomes unnecessary, LSI-ization of one chip will become easy.

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[Translation done.]

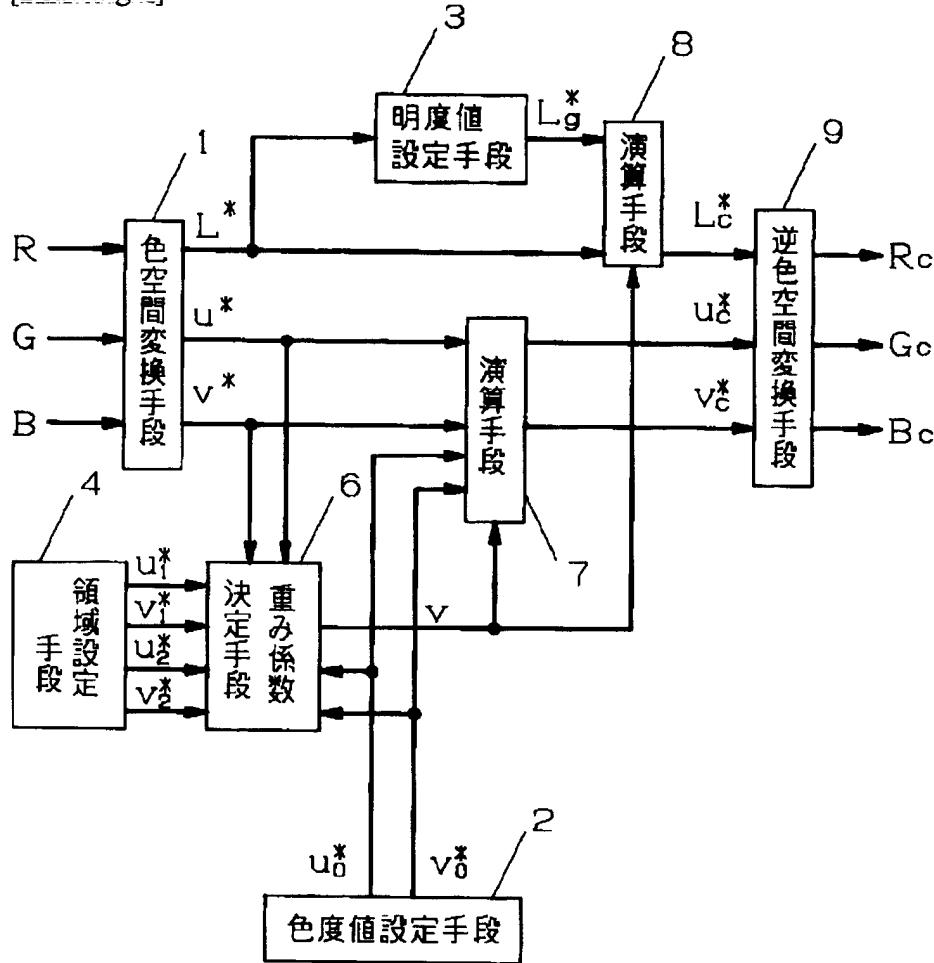
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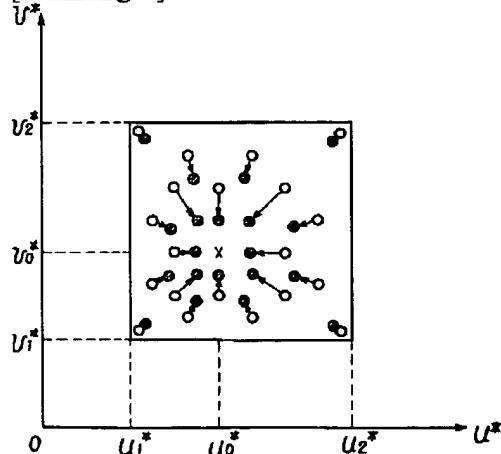
1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

## DRAWINGS

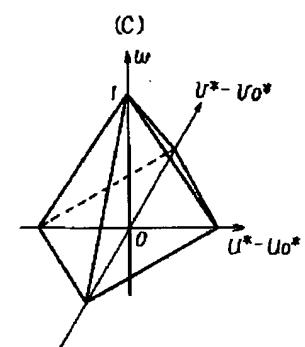
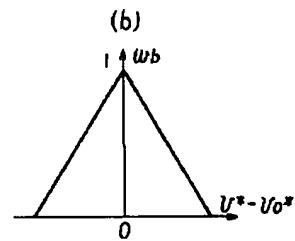
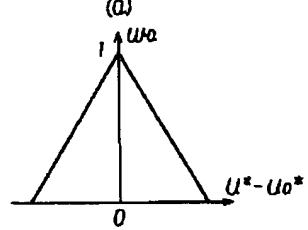
[Drawing 1]



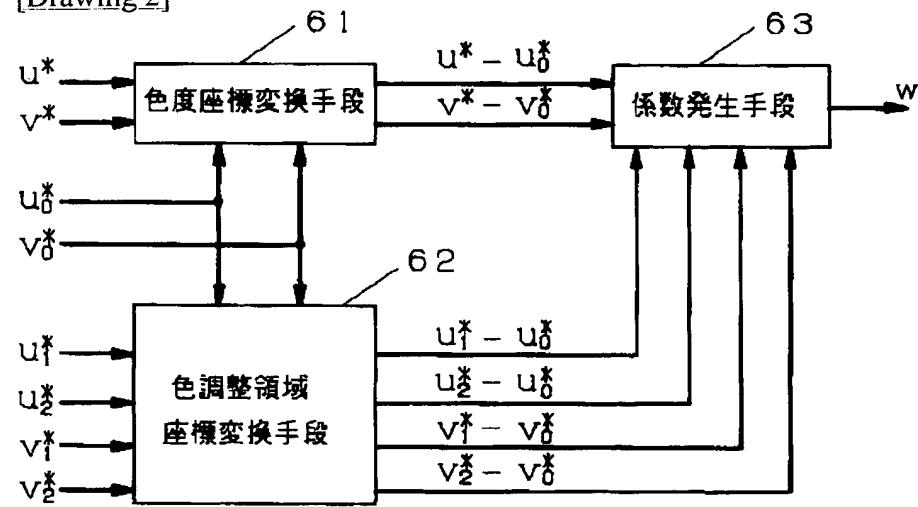
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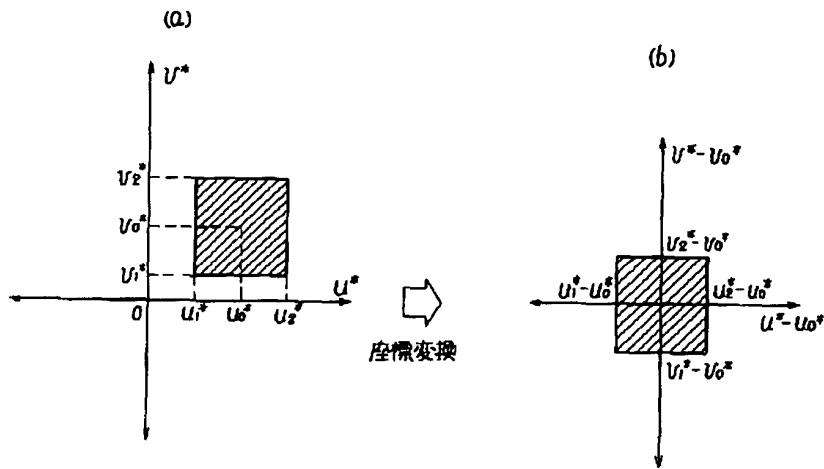
[Drawing 12]



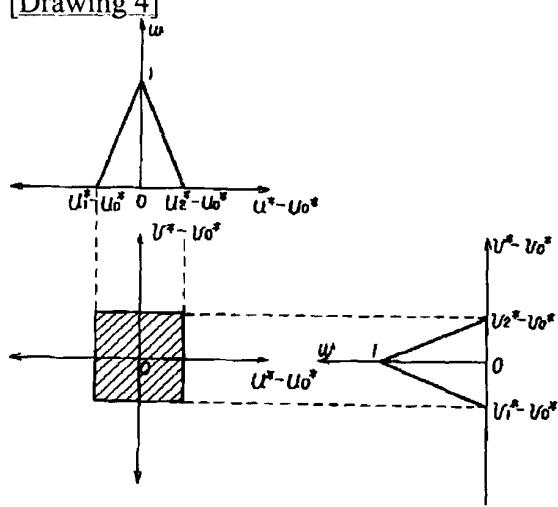
[Drawing 2]



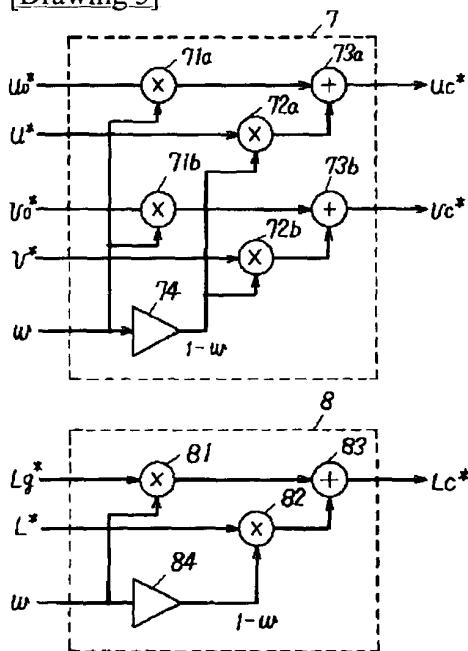
[Drawing 3]



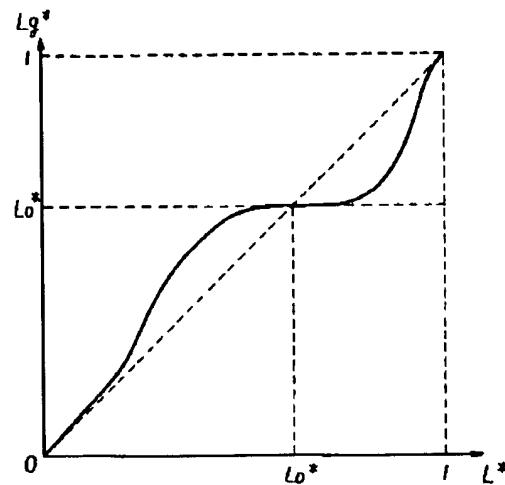
[Drawing 4]



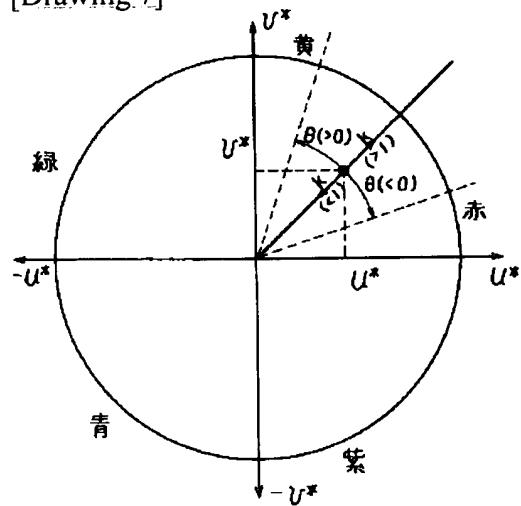
[Drawing 5]



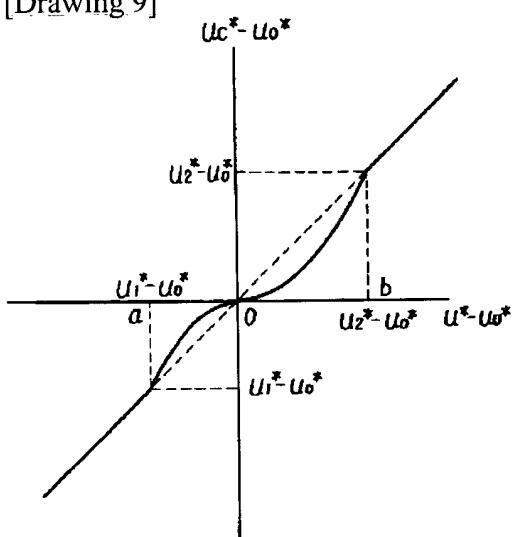
[Drawing 6]



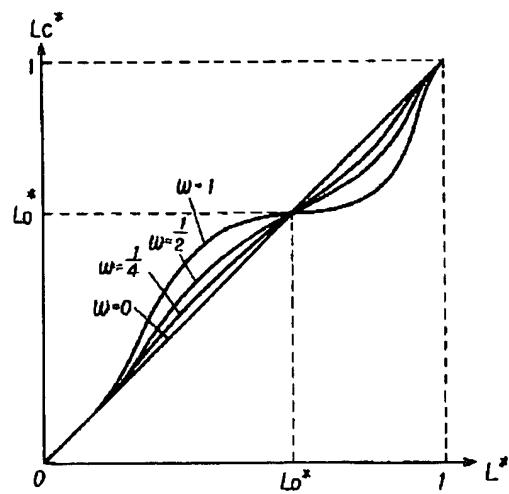
[Drawing 7]



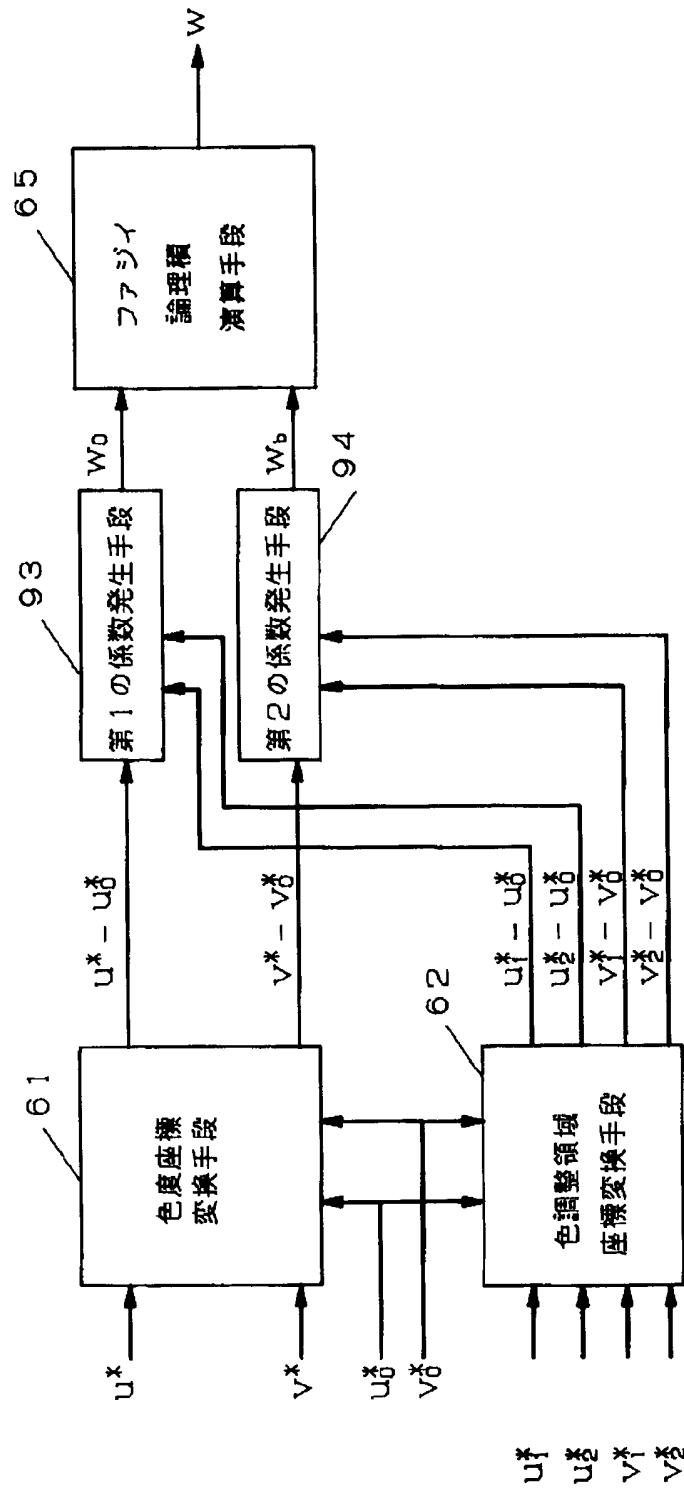
[Drawing 9]



[Drawing 10]



[Drawing 11]



[Translation done.]

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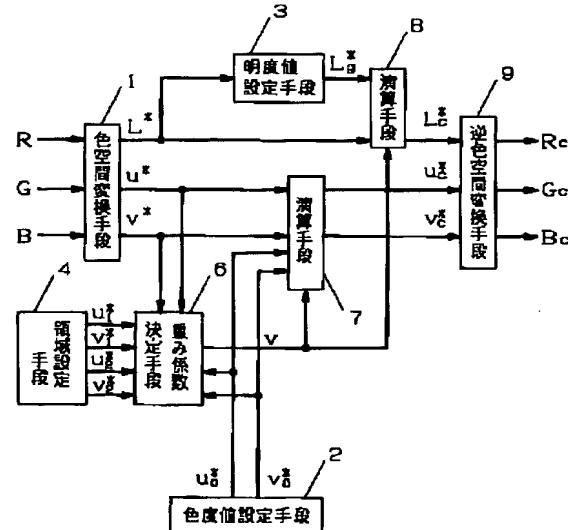
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(54) 【発明の名称】 色調整装置

(57) 【要約】

【目的】 記憶色に対する選択的な自動色調整を行う。

【構成】 色相成分と彩度成分とを示す色度平面内で、  
入力色度値と色度値設定手段2で設定される基準色度値  
との差に応じて、係数決定手段6により重み係数を決定  
し、この重み係数に応じて、基準色度値と入力色度信号、  
および基準明度値と入力明度値を各々内分し出力色  
信号とするものである。



1

## 【特許請求の範囲】

【請求項1】入力されるカラー画像信号の色の3属性のうち、明度成分を表わす信号を入力明度信号、前記明度成分を除いた2属性で表現される色度平面上の信号を入力色度信号とし、所定の基準色度値を設定する色度値設定手段と、この基準色度値を含む色度平面上の領域を設定する領域設定手段と、前記領域設定手段の設定領域外では0の値を出力し、前記領域設定手段の設定領域内では入力される色度信号と前記基準色度信号との距離が近いほど1に近い値を出力する重み係数決定手段と、前記係数発生手段の出力値により前記入力色度信号と前記基準色度信号とを内分する演算手段とを備え、前記演算手段の出力を出力色度信号とすることを特徴とする色調整装置。

【請求項2】入力されるカラー画像信号の色の3属性のうち、明度成分を表わす信号を入力明度信号、前記明度成分を除いた2属性で表現される色度平面上の信号を入力色度信号とし、所定の基準色度値を設定する色度値設定手段と、この基準色度値を含む色度平面上の領域を設定する領域設定手段と、前記領域設定手段の設定領域外では0の値を出力し、前記領域設定手段の設定領域内では入力される色度信号と前記基準色度信号との距離が近いほど1に近い値を出力する重み係数決定手段と、所定の明度値を設定する明度値設定手段と、前記係数発生手段の出力値により前記入力明度信号と前記明度値設定手段の出力とを内分する演算手段とを備え、前記演算手段の出力を出力明度信号とすることを特徴とする色調整装置。

【請求項3】明度値設定手段は、入力明度信号を階調変換することにより明度値の設定を行なうことを特徴とする請求項2記載の色調整装置。

【請求項4】入力されるカラー画像信号を輝度信号と色差信号に変換する色空間変換手段を備え、色差信号を色度信号とすることを特徴とする請求項1、2または3記載の色調整装置。

【請求項5】重み係数決定手段は、原点を基準色度値とする座標系に入力色度信号を変換する色度座標変換手段と、この色度座標変換手段により変換された新たな色度座標での原点で1の値を出力し、原点からの距離に応じて連続的に減少し、領域設定手段の設定領域の境界部で0になる重み係数を発生する係数発生手段とを備えたことを特徴とする請求項1、2、3または4記載の色調整装置。

【請求項6】領域設定手段が色度平面上で設定する領域は矩形であり、重み係数決定手段は、前記色度平面の2つの座標軸に各々平行な重み成分を発生する2つの係数発生手段の出力のファジィ論理積により重み係数を発生するファジィ論理積演算手段を備え、前記係数発生手段は、基準色度値の対応する重み係数が1の値を出力し、離れるに従い連続的に減少し、領域決定手段の設定領域

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の境界で0である重み係数を発生することを特徴とする請求項1、2、3または4記載の色調整装置。

## 【発明の詳細な説明】

## 【0001】

【産業上の利用分野】本発明はカラープリンタ、カラー複写機やカラーＴＶ等のカラー画像を取り扱う機器において画像内の他の色を保存したまま、特定の範囲の色のみを希望の色に自動的に変化させが出来る自動色調整装置に関するものである。

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## 【0002】

【従来の技術】近年、各種カラー画像機器の高画質化、インテリジェント化に伴い、利用者の感性にもとづく要求に応えられる色調整が望まれている。

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【0003】従来から、色調整に要求されてきている具体的な調整内容は様々である。画像全体の明るさの調整、色の濃さの調整、RGBやCMYの色バランスの調整など単純なものから、画像中の特定の位置にある部分のみの色変換などのように画像の位置情報を用いたものや、特定の色領域に含まれる色のみに対する色相や彩度や明るさの調整など高度なものも含まれる。

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【0004】これらの調整は、主に利用者が出力画像に対して持つ不満の解消を目的としたもので、通常これらのカラー画像機器の性能が上がり、十分忠実な色再現が行えるようになると要求が減少すると考えられる。

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【0005】ところが、前述の画質に対する不満のうちで、装置の性能とは別に人間の持つ心理的な要求に基づくものがある。一般に、「忠実な色再現」に対して「好ましい色再現」と呼ばれるものがあり、「記憶色」がその代表である。例えば、肌色や木々の緑などのように、心理的に「こんな色であるはず」または「あって欲しい」というような色は、記憶色と呼ばれている。

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【0006】特に、ビデオプリンタなどのハードコピー装置では、原画と独立してハードコピーだけが後まで残るため、原画に忠実な色を再現することよりも、見る人にとって好ましい色を再現することが重要になってくる。これは、記憶色に対してより顕著で、特に肌色は、好みも含めてきわめて重要であり、被写体に忠実な肌色が好まれることが多く、記憶色に対する色調整が要求される一因になっている。

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【0007】実際、スタジオで撮影されているテレビ放送のハードコピーであれば、出演者は化粧を行ない十分な光量の光源の下で撮影されているため、通常視聴者にとっても好ましい肌色が再現されることが多い。

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【0008】しかし、それ以外の放送例えばドラマの1シーンなどは、記憶に近い好ましい肌色が再現されるることは少ない。まして、素人がムービー（カメラ一体型ＶＴＲ）で撮影したものは、被写体の化粧もなく、照明も自然光だけで光量が少なかったり顔に影があつたりする場合が多く、ホワイトバランスもオートであるため背景の色に左右されているため、記憶色の好ましい肌色が再

3

現されることは極めて難しい。

【0009】一方從来の色調整では、テレビを例にあげると、NTSCからRGBに復調する際に、クロマの位相やレベルを調整し、輝度のオフセットを調整することで色調整が行なえる構成をとっている。具体的には、クロマの位相を変化させることで色相が回転し、クロマのレベルを変化させることで彩度が調整できる。また、輝度のオフセットの変化は明度調整として概略働く。この調整法は、3属性を持つ色情報を、人間にとって感覚的に理解し易い明度と色相と彩度の3属性により調整することになるため、簡単な割には扱い易く優れたものである。

【0010】また、装置規模は大きいが、入力信号を明度と色相と彩度の3属性を持つ色空間に変換し、その色空間上で特定色のみの色相の回転と彩度調整を行い、その結果を元の色空間に逆変換することにより、特定の色領域に対して色調整が可能な選択的色調整装置も提案されている（「画像電子学会誌」第18巻 第5号 302～312ページ）。

【0011】

【発明が解決しようとする課題】しかしながら上記のような從来の色調整装置では、記憶色に対する色調整が難しく、自動的に記憶色に調整することはさらに難しいという課題がある。

【0012】例えば、記憶色として肌色を例にあげると、テレビで用いられている色調整方式では、色相調整はあらゆる色を同時に回転できるに過ぎず、彩度調整と明度調整も全画面に対して一様にしか作用させることはできないため、他の色には影響を与えることなく、肌色だけを好みの色に近づけることはできない。

【0013】また、從来の選択的色調整装置は、色空間中の特定の色領域に対してのみ色相の回転や彩度の調整を行なうもので、入力された肌色を含む色領域が他の色と分離可能であれば、その色領域以外の色に影響を与えることはない。しかし、その色領域の中で入力信号の肌色を、どの方向に色相を回転させ彩度をどのように調整すれば好みの肌色になるかは、入力された肌色の色相と彩度により様々であるため、その判断は人間が行い指示する必要がある。

【0014】さらに、現実にはひとつの顔画像の中にも様々な肌色が含まれているため、入力された全ての肌色が記憶色の肌色に対して、色相、彩度、明度とも同じ方向に同じ度合で変位していることはきわめて希である。通常は、記憶色の肌色に対して、様々な方向と度合で変位しているため、從来の選択的色調整装置で肌色が含まれる領域を特定できたとしても、入力画像中の全ての肌色を記憶色に近づけることはできないことになる。

【0015】以上のように、從来の手法では、記憶色に対する調整は極めて難しく、それを自動で行なうことはさらに難しいという課題がある。

4

【0016】本発明は上記課題に鑑み、画像中の全ての肌色に対して、記憶色からの変位の方向と度合に応じて補正方向を自動的に決定し、記憶色の肌色に自然に近づけることができる色調整装置の提供を目的とし、回路構成が簡単で、映像信号に対してリアルタイムで処理できるような高速処理が可能な色調整装置を提供するものである。また、当然肌色以外の記憶色にも同様に適用できるものである。

【0017】

【課題を解決するための手段】上記課題を解決するためには本発明の色調整装置は、入力されるカラー画像信号の色の3属性のうち、明度成分を表わす信号を入力明度信号、前記明度成分を除いた2属性で表現される色度平面上の信号を入力色度信号とし、所定の基準色度値を設定する色度値設定手段と、この基準色度値を含む色度平面上の領域を設定する領域設定手段と、前記領域設定手段の設定領域外では0の値を出力し、前記領域設定手段の設定領域内では入力される色度信号と前記基準色度信号との距離が近いほど1に近い値を出力する重み係数決定手段と、前記重み係数決定手段の出力値により前記入力色度信号と前記基準色度信号とを内分する演算手段とを備えたものであり、さらに、所定の基準色度値を設定する色度値設定手段と、この基準色度値を含む色度平面上の領域を設定する領域設定手段と、前記領域設定手段の設定領域外では0の値を出力し、前記領域設定手段の設定領域内では入力される色度信号と前記基準色度信号との距離が近いほど1に近い値を出力する重み係数決定手段と、所定の明度値を設定する明度値設定手段と、前記重み係数決定手段の出力値により前記入力明度信号と前記明度値設定手段の出力とを内分する演算手段を備えたものである。

【0018】

【作用】本発明は上記した構成によって、入力されるカラー画像信号の色の3属性のうち明度成分を除いた2属性で表現される色度平面上の入力色度信号に対して、色度値設定手段が設定した記憶色の基準色度値と入力色度信号との色度平面上での距離に応じて、重み係数決定手段により重み係数を決定し、その重み係数に応じて、入力色度信号の座標と基準色度値の座標を結ぶ直線上の色度値を決定し、出力色度値とすることにより、常に入力色度値を基準色度値に近づけるように色相と彩度の補正方向と度合を決定し補正を行なう。

【0019】また、入力明度信号と入力色度信号に対して、色度値設定手段が設定した記憶色の基準色度値と入力色度信号との色度平面上での距離に応じて、重み係数決定手段により重み係数を決定し、その重み係数に応じて、入力明度色度信号の値と明度値設定手段の出力する基準明度値を結ぶ直線上の明度値を決定し、出力明度信号とする。

【0020】以上の動作により、入力色度信号が基準色

度値に対してどの方向に変位していくても自動的に正しく基準色度値および基準明度値に寄せることができるという作用効果を有し、寄せる度合は重み係数決定手段で自由に決定できるため自然な形で記憶色に引き込むことが可能になる。

## 【0021】

【実施例】以下本発明の第1の実施例の色調整装置について、図面を参照しながら説明する。

【0022】動作説明を行なう前に、本発明で述べる色の3属性のうち、色相成分と彩度成分を表わす色度平面上の2要素を表わす色度信号について説明する。

【0023】色相成分と彩度成分を表わす平面を直交座標系で表わす色度信号としては、輝度色差信号（例えばY、R-Y、B-Y信号やY、U、V信号等）の色差信号や、輝度クロマ信号（YC信号）のクロマ信号、CIE1976均等知覚色空間（L\* u\* v\*）の知覚色度指数（u\* v\*）、CIE1976均等知覚色空間（L\* a\* b\*）の知覚色度指数（a\* b\*）、HLS空間のHS信号などが挙げられる。本発明では、これらの色相と彩度の2属性を持つ信号を色度信号と呼ぶ。

【0024】図1は本発明の第1の実施例における色調整装置の概略構成を示すブロック図である。図1において、1は入力された色信号（本実施例ではRGB信号とする）を色空間（本実施例ではCIE1976均等知覚色空間（L\* u\* v\*）上の座標を表わす信号（L\*、u\*、v\*）に変換する色空間変換手段である。2は記憶色に相当する基準色の色度座標を表わす色度信号（u0\*、v0\*）を設定する色度値設定手段、3は同様に基準色の明度の基準値（Lg\*）を設定する明度値設定手段、4は注目色を含む色調整領域を設定する領域設定手段である。

【0025】6は入力される色度信号（u\*、v\*）に応じて領域設定手段4で設定された色調整領域内で、色の調整度合を示す重み係数wを決定する重み係数決定手段、7は色空間変換手段1の出力のうちの色度信号（u\*、v\*）と色度値設定手段2の出力色度信号（u0\*、v0\*）とから重み係数決定手段6で決定された重み係数wに基づいて色調整された色度信号を出力する演算手段、8は色空間変換手段1の出力のうちの明度信号（L\*）と明度値設定手段3の出力（Lg\*）とから重み係数決定手段6で決定された重み係数wに基づいて色調整を行なった明度信号を出力する演算手段、9は演算手段7の出力色度信号（uc\*、vc\*）と演算手段8の出力明度信号（Lc\*）をRGB信号に変換する逆色空間変換手段である。

【0026】また図2は、重み係数決定手段6の概略構成のブロック図である。61は均等色知覚空間上の色度平面を、基準色の色度座標が原点になるように座標変換を行なう色度座標変換手段で、具体的には入力される色度信号（u\*、v\*）から基準色度座標（u0\*、v0\*）を

ベクトル減算するものである。同様に、62は領域設定手段4が設定した色調整領域（u1\*、u2\*、v1\*、v2\*）に座標変換を施す色調整領域座標変換手段で、63は色度座標変換手段61の出力の色度信号（u\*-u0\*、v\*-v0\*）と色調整領域座標変換手段62で変換された新たな色調整領域（u1\*-u0\*、u2\*-u0\*、v1\*-v0\*、v2\*-v0\*）とから重み係数wを発生する係数発生手段である。

【0027】さらに図3は色度座標変換手段61及び色調整領域座標変換手段62の動作説明図である。図3に示すように基準色度値を表わす色度信号（u0\*、v0\*）が原点となるように座標変換を行なう。なお、図3（a）に示す矩形の斜線部は領域設定手段4で設定される色調整領域を示すものであり、図3（b）に示す矩形の領域は色調整領域座標変換手段62で変換された色調整領域である。

【0028】図4は、係数発生手段63が発生する重み係数wを色度座標変換手段61で変換される座標上で図示したものである。図に示すように、重み係数wは変換された座標上で、色度座標変換手段61に入力される色度信号（u\*、v\*）が原点、つまり基準色度値（u0\*、v0\*）と一致したときに最大（w=1）で、領域の境界へ離れるに従い連続的に小さくなり、境界では重み係数wが0になるように設定する。また、境界の外は一様に0である。本実施例では、簡単のために直線的な分布としている。

【0029】図5は演算手段7と演算手段8の構成を示すブロック図である。74、84は重み係数wの1の補数を出力する反転手段、71-a、71-bは色度値設定手段の基準色度値（u0\*、v0\*）と重み係数wとを各々乗算する乗算器、81は明度値設定手段の基準明度値（Lg\*）と重み係数wとを各々乗算する乗算器、72-a、72-bは色空間変換手段1の出力の色度信号（u\*、v\*）と重み係数の補数1-wとを各々乗算する乗算器、82は色空間変換手段1の出力の明度信号（L\*）と重み係数の補数1-wとを乗算する乗算器、73-aは乗算器71-aの出力と乗算器72-aの出力とを加算する加算器、73-bは乗算器71-bの出力と乗算器72-bの出力とを加算する加算器、83は乗算器81の出力と乗算器82の出力とを加算する加算器である。

【0030】従って、演算手段7は色空間変換手段1の出力のうちの色度信号（u\*、v\*）と基準色度値（u0\*、v0\*）とを重み係数wにより内分することになる。同様に、演算手段8は色空間変換手段1の出力のうちの明度信号（L\*）と基準明度値（Lg\*）とを重み係数wにより内分することになる。この演算を式で表わすと式（1）（2）および（3）で示すことができる。

## 【0031】

$$uc^* = (1-w) \cdot u^* + w \cdot u0^* \quad \dots (1)$$

7

$$vc^* = (1-w) \cdot v^* + w \cdot v0^* \dots (2)$$

$$Lc^* = (1-w) \cdot L^* + w \cdot Lg^* \dots (3)$$

また、図6は、明度値設定手段3の入出力特性を表わすグラフである。

【0032】記憶色の色相と彩度を表わす色度値は、色度値設定手段により半固定の値 ( $u0^*$ ,  $v0^*$ ) を設定している。記憶色の明度の基準値も固定値 ( $L0^*$ ) にする方法もあるが、本実施例では、より自然な画像を得るために、図のような明度入力の関数としている。

【0033】目的は、入力色の中で、色相と彩度が所定の記憶色と判断できる色でも、明度が記憶色と大きく異なる場合には明度に対して不自然な大きな補正を避けるものである。

【0034】以下、本発明の第1の実施例の動作について、図1から図6を用いて説明する。

【0035】まず、入力された色信号RGBは色空間変換手段1により、CIE1976均等知覚色空間 ( $L^*$ ,  $u^*$ ,  $v^*$ ) を表わす信号に変換される。この変換は2段階で表わされ、第1段を式(4) (5) および(6)、第2段を式(7) (8) および(9) に示す。

【0036】

$$X = 0.607 \cdot R + 0.173 \cdot G + 0.200 \cdot B \dots (4)$$

$$Y = 0.299 \cdot R + 0.586 \cdot G + 0.115 \cdot B \dots (5)$$

$$Z = 0.066 \cdot G + 1.116 \cdot B \dots (6)$$

$$L^* = 116 \times (Y/Y0)^{1/3} - 16 \dots (7)$$

$$u^* = 13 \times L^* \times (u-u0) \dots (8)$$

$$v^* = 13 \times L^* \times (v-v0) \dots (9)$$

$$\text{但し } u = 4X/(X+15Y+3Z)$$

$$v = 6Y/(X+15Y+3Z)$$

$$Y0 = 1, u0 = 0.20089, v0 = 0.30726$$

CIE1976均等知覚色空間 ( $L^*$ ,  $u^*$ ,  $v^*$ ) 上において、明度を除いた色度平面上の色度値 ( $u^*$ ,  $v^*$ ) は、極座標では色相成分と彩度成分を表わすものであるので、この平面内で色調整を行なえば、明るさを保ったまま調整することができる。図7は、色度平面上で行なう従来の色補正の概念を説明する図である。ある色の色度 ( $u^*$ ,  $v^*$ ) を極座標に変換し角度 $\theta$ だけ回転させると色相が回転し、原点からの距離を $k$ 倍すると彩度が $k$ 倍になる。

【0037】次に、領域設定手段4について説明する。本実施例では、回路構成を簡単にするため、領域決定手段4が設定する領域の形状を、図4に示すように基準色度を含みu軸とv軸に平行な矩形の形状としている。領域形状は、所望の記憶色に相当する色の色度平面上における分布に応じて任意な形状にすることも可能である。

【0038】重み係数決定手段6は、入力される色の色度値 ( $u^*$ ,  $v^*$ ) と基準色度値 ( $u0^*$ ,  $v0^*$ ) との距離に応じて重み係数 $w$ を決定するものであり、この重み係数決定手段3の動作について図2、図3及び図4を用いてさらに詳細に説明する。

8

【0039】図3に示すように、重み係数決定手段6に入力される色度信号 ( $u^*$ ,  $v^*$ ) を色度座標変換手段61により、まず注目色の色度座標を表わす色度信号 ( $u0^*$ ,  $v0^*$ ) が原点となるように座標変換を行なう。

【0040】そして領域設定手段4で設定された色調整領域 ( $u1^*$ ,  $u2^*$ ,  $v1^*$ ,  $v2^*$ ) を色調整領域座標変換手段62で座標変換した色調整領域 ( $u1^* - u0^*$ ,  $u2^* - u0^*$ ,  $v1^* - v0^*$ ,  $v2^* - v0^*$ ) (図4に示す斜線の領域) に基づいて、係数発生手段63の入出力特性を求める。この重み係数 $w$ は、図4に示すように座標変換された平面上で原点つまり入力される色度信号が注目色の時に最大 ( $w = 1$ ) で、領域の境界に近づくにつれて、連続的に減少し、境界で最小 ( $w = 0$ ) になるように設定しておく。この係数発生手段63は例えばルックアップテーブルで構成すれば容易に構成できる。

【0041】このように重み係数決定手段6により決定された重み係数 $w$ により、色空間変換手段1の出力のうちの色度信号 ( $u^*$ ,  $v^*$ ) と基準色度値 ( $u0^*$ ,  $v0^*$ ) とから、演算手段7により、式(1) (2) および(3)に示す演算、つまり内分演算により色調整された色度信号 ( $uc^*$ ,  $vc^*$ ) が得られる。

【0042】同様に、重み係数 $w$ により、色空間変換手段1の出力のうちの明度信号 ( $L^*$ ) と基準明度値 ( $Lg^*$ ) とから、演算手段8により、同様の内分演算により色調整された明度信号 ( $Lc^*$ ) が得られる。

【0043】以上述べてきた、本発明の色調整演算を実際に行なった例を図8に示す。この例は、係数発生手段63の入出力特性が図4で示したものとした場合のものであり、基準明度値は図6の関数で決定している。

【0044】ただし、図8は色度平面であるため、色相と彩度の変化だけが表わされており、明度変化は見ることができない。

【0045】図中の×印は基準色度値を表わしており、色空間変換手段1から入力された色度値を黒丸、色調整後の色度値を白丸で表わしている。この図からもわかるよう色調整後の色度座標は、基準色度値へ自然な形で引き込まれるような変化をしている。変化の特徴としては、

- ・入力が基準色度値に一致したときは変化しない。
- 【0046】・入力が設定領域より外の色は変化しない。
- ・変化の大きさは基準色度値と設定領域の境界の中間付近が最も大きい。

【0047】・設定領域内の全ての色度値の変化は連続で、かつ逆転は生じない。

従って、設定領域内の多くの色が自然に記憶色である基準色度値に引き込まれながら、不自然な色変化を防止できることになる。

【0048】係数発生手段63の特性が簡単な直線状の形状であるのにかかわらず、このような優れた調整結果

が得られる理由は、本発明の色調整が内分演算を基本にしていることによる。なぜなら、重み係数が入力色度値と基準色度値との距離に対して線形的であり、内分演算も同じく距離に対して線形である。さらに補正色度値は両者の積で変化するため、色度変化は2次関数となり放物線的な変化になるためである。図9は、横軸を入力色度値と基準色度値の水平距離、縦軸を出力色度値と基準色度値との水平距離としたグラフである。図中のaとbは設定領域の境界と基準色度値との水平距離である。このグラフから判るように、原点を中心にふたつの放物線を組み合わせた形状をしている。原点とa, bの外側は変化がなく、原点の付近の両側の色は自然に原点に引き込まれる特性であり、色相と彩度変化の逆転もなく滑らかな連続的な変化になっている。また、元の色度（点線）との変化の大きさは、原点と設定領域の中間付近が最も大きくなる。

【0049】原点へ引き込み具合は、重み係数決定手段6の特性を変化させることで自由に調整することが可能である。

【0050】図10は、明度入力( $L'$ )に対する明度出力( $Lc^*$ )の特性を表わすグラフである。入力色度値により前述の重み係数wが変化したときの、明度に対する入出力特性の変化を図示している。

【0051】明度の入出力特性は、入力色度が基準色度に近い場合即ちwが1に近い場合には、図6に示す基準明度出力に一致した特性になるため、入力明度値が記憶色の明度値( $L0^*$ )付近の明度を強制的に( $L0^*$ )に引き込む特性になる。また、入力色度が基準色度と離れた場合即ちwが0に近い場合は、明度に対する補正是行なわれることになる。

【0052】このため、例えば、記憶色を肌色とした場合、色度値が肌色の範囲と判断した場合は、明度も好ましい肌色の明度に引き込む作用をし、それ以外の色の場合は明度変化を生じさせない作用がある。

【0053】なお、本実施例では、色空間変換手段1を色信号からCIE1976均等知覚色空間( $L' u' v'$ )に変換するものとしたが、先ほど述べたように例えば色信号からCIE1976均等知覚色空間( $L' a' b'$ )に変換するものや、輝度色差信号(例えばY、R-Y、B-Y信号やYUV信号)などの変換を行なうものでも同様の構成で、同じ効果を得ることができる。特に、輝度色差信号はRGBやNTSCからの相互変換がきわめて容易であり、実用価値が高い。

【0054】また、本実施例では、重み係数決定手段6に色度座標変換手段61や色調整領域座標変換手段62を設けて、基準色度値を原点に移動させてから重み係数wを発生したが、座標変換を行なわずに直接色度平面上で重み係数の発生を行なうことも可能である。

【0055】以上述べてきたように、色相成分と彩度成分とを示す色度平面内で、色度値信号設定手段により設

定された基準色度値とこの基準色度値を含む設定領域内の入力色度値に対して、入力色度値と基準色度値との差に応じて、重み係数決定手段により重み係数を決定し、入力色度値と基準色度値とから重み係数に応じて出力色度値を決定することにより、連続性を保存したまま、色調整領域の外と内とで色が逆転することもなく、自然な色調整を行なうことができ、任意の記憶色付近の色自然に記憶色に引き込むことが可能になる。

【0056】また、色度平面を極座標に変換せず直交座標のままで処理できるため、複雑な極座標系への非線形変換が不要なため、非常に簡単に構成でき、回路規模を小さくできる。

【0057】特に色空間変換手段により変換される色空間を輝度色差信号で表わすものとすれば、非線形演算を行なう必要がなくなり、小型で、しかもリアルタイムで処理できる構成とすることができる。

【0058】本発明の第2の実施例について述べる。第2の実施例の構成としては、図1と同じもので構成され、重み係数決定手段6の構成のみが異なる。本実施例の重み係数決定手段6の構成を図11に示す。本実施例において、重み係数決定手段6以外の構成及びその動作は同じであるので詳細な説明は省略し、重み係数決定手段6の構成及びその動作についてのみ説明する。

【0059】図12は本実施例の重み係数決定手段6の動作説明図である。図11において、61は色度信号( $u^*, v^*$ )のうち注目色の色度座標を表わす色度信号( $u0^*, v0^*$ )が色度座標上の原点になるように座標変換を行なう色度座標変換手段、62は領域設定手段4で設定された色調整領域( $u1^*, u2^*, v1^*, v2^*$ )を同様に座標変換を施す色調整領域座標変換手段で、93は色度座標変換手段61の出力 $u^* - u0^*$ を入力とし、色調整領域座標変換手段62で変換された色調整領域( $u1^* - u0^*, u2^* - u0^*$ )に基づいて図12(a)に示す重み係数 $wa$ を出力する第1の係数発生手段、94は色度座標変換手段61の出力 $v^* - v0^*$ を入力とし、色調整領域座標変換手段62で変換された色調整領域( $v1^* - v0^*, v2^* - v0^*$ )に基づいて図12(b)に示す重み係数 $wb$ を出力する第2の係数発生手段、65は第1及び第2の係数発生手段93、94の各々の出力する重み係数 $wa$ 、 $wb$ から式(10)に示した $min$ 演算によるファジィ論理積を取り、図12(c)に示す重み係数 $w$ を出力するファジィ論理積演算手段である。

【0060】

$$w = \min(wa, wb) \quad \dots (10)$$

この様に構成された本実施例の動作について説明する。第1の実施例とその動作は同じであるので、重み係数決定手段6を中心に簡単に説明する。

【0061】重み係数決定手段6に入力される色度信号( $u^*, v^*$ )を色度座標変換手段61により、まず注目色の色度信号( $u0^*, v0^*$ )が原点となるように座標変

11

換を行なう。領域設定手段4で設定された色調整領域( $u1^*$ 、 $u2^*$ 、 $v1^*$ 、 $v2^*$ )を色調整領域座標変換手段62で変換された色調整領域( $u1^*-u0^*$ 、 $u2^*-u0^*$ 、 $v1^*-v0^*$ 、 $v2^*-v0^*$ )に基づいて、第1の係数発生手段93では、色度座標変換手段61の出力 $u^*-u0^*$ を入力とし、例えば図12(a)に示すような一次元の重み係数 $wa$ を出力する。同様に、第2の係数発生手段94では、色度座標変換手段61の出力 $v^*-v0^*$ を入力とし、図12(b)に示すような一次元の重み係数 $wb$ を出力する。そして、各々の入力信号 $u^*-u0^*$ 、 $v^*-v0^*$ に対して発生した一次元の重み係数 $wa$ 、 $wb$ から、ファジィ論理積演算手段65による $min$ 演算によるファジィ論理積を取り、図12(c)に示す二次元の重み係数 $w$ を出力する。

【0062】この後、この重み係数を用いて第1の実施例と同様に、明度および色度に対する色調整を行ない、その結果を逆色空間変換手段8は、明度 $L^*$ と色度( $uc^*$ 、 $vc^*$ )をRGBに変換し、色調整された信号を得ることができる。

【0063】以上述べてきたように、係数発生手段を入力される色相成分と彩度成分を表わす平面の直交座標系の2要素で表される色度信号のそれぞれの要素軸に関して、軸上の重み係数が1で、軸から離れるに従い連続的に減少し、前記色調整領域決定手段で決定される色調整領域の各軸に平行な境界で0である重み係数を発生する2個の重み係数決定手段と、この2個の重み係数決定手段のそれぞれの出力のファジィ論理積により重み係数を発生するファジィ論理積演算手段とで構成することにより、重み係数決定手段の入出力特性を1次元で構成でき、またファジィ論理積演算手段も構成が簡単なため、より簡単に入出力特性を決定できる効果がある。

【0064】また、説明を簡単にするために本実施例では、色度値設定手段が記憶色に対する好ましい固定の色度値を設定するものとして説明したが、何かの信号に応じて変化させることもできる。例えば、多くの場合、好ましい肌色の色度値は明度により若干変化するので、明度信号に応じて基準色度値を変化させると、記憶色に対する自動色調整の補正性能を高めることができる。

【0065】また、本実施例では、基準明度値は、明度信号の閾値として変化するものを説明したが、装置を簡単にするために固定にすることも可能である。

【0066】

【発明の効果】以上述べてきたように、本発明は、色の3属性のうち色相成分と彩度成分を表わす色度平面において、所望の色領域以外の色に対して何の変化も与えず、所望の色のみに対して色調整を施すことが可能になる。

【0067】本発明の色調整は、基準色度値として設定した例えば記憶色などの色に対して、色度平面を用いて色相と彩度を基準色度値に自然に引き込み、明度に関し

10

12

ても基準明度値に自然に引き込むことにより、例えば、入力された肌色を所望の記憶色の肌色に自動的に引き込むことができる。また、この色調整は、色の連続性が保存され色の逆転も起こらず、自然な色調整を行なうことができるものである。

【0068】したがって、原画と独立してハードコピーだけが後まで残るビデオプリンタなどのハードコピー装置でも、好みも含めてきわめて重要な肌色等の記憶色に対して、被写体が化粧もなく特別な照明も用いない場合が多い素人撮影の場合でも、「こんな色であるはず」または「あって欲しい」という肌色に自動調整されることになり、「好ましい色再現」が実現できる。

【0069】また、本発明の構成は、色度値を直交座標のまま処理するので、極座標系への複雑な非線形な変換処理が不要になり、回路規模の小さい非常に簡単な構成で実現できる。

【0070】そして特に色空間変換手段により変換される色空間を輝度色差信号で表わすものとすれば、非線形演算を行なう必要がなくなり、小規模な構成で、しかもリアルタイムで処理できる構成とができる。

【0071】また、ファジィ論理積による重み係数を発生する構成を用いると、大きなROMテーブルが必要なくなるため1チップのLSI化が容易になる。

【図面の簡単な説明】

【図1】本発明の第1の実施例における色調整装置の構成を示すブロック図

【図2】同実施例における重み係数決定手段の構成を示すブロック図

【図3】同実施例における色度座標変換手段の動作説明図

【図4】同実施例における係数発生手段の入出力特性図

【図5】同実施例における演算手段の構成を示す回路図

【図6】同実施例における明度値設定手段の入出力特性図

【図7】色度平面による一般の色調整方法の説明図

【図8】同実施例における色調整装置の調整効果を示す説明図

【図9】同実施例における色調整装置の調整効果を示す色度0の入出力特性図

【図10】同実施例における色調整装置の調整効果を示す明度の入出力特性図

【図11】本発明の第2の実施例における色調整装置の重み係数決定手段の構成を示すブロック図

【図12】同実施例における重み係数決定手段の動作説明図

【符号の説明】

1 色空間変換手段

2 色度値設定手段

3 明度値設定手段

4 領域設定手段

50

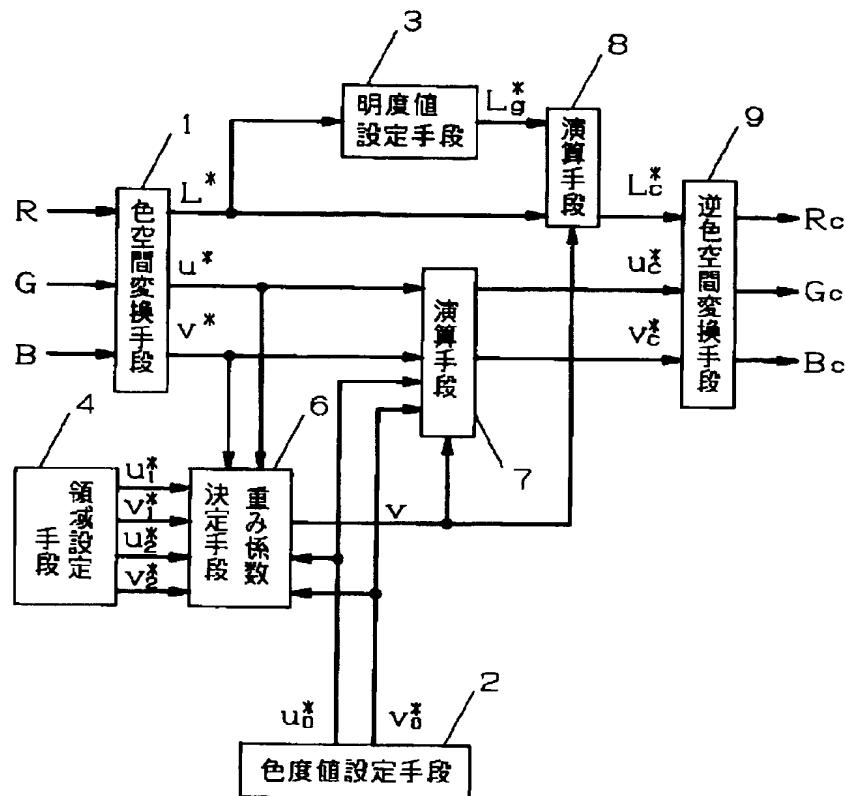
13

6 重み係数決定手段  
 7、8 演算手段  
 9 逆色空間変換手段  
 6 1 色度座標変換手段  
 6 2 色調整領域座標変換手段  
 6 3 係数発生手段

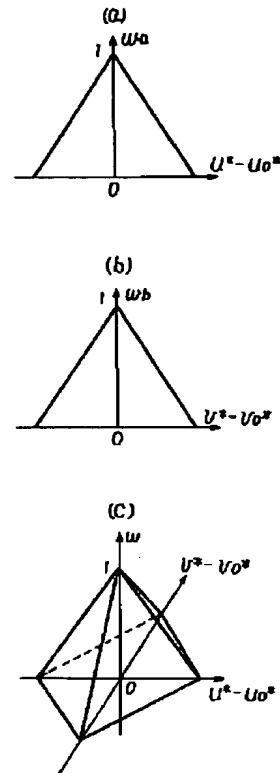
14

6 5 ファジイ論理積演算手段  
 7 1 a、7 1 b、7 2 a、7 2 b、8 1、8 2 乗算器  
 7 3 a、7 3 b、8 3 加算器  
 7 4、8 4 反転手段  
 9 3 第1の係数発生手段  
 9 4 第2の係数発生手段

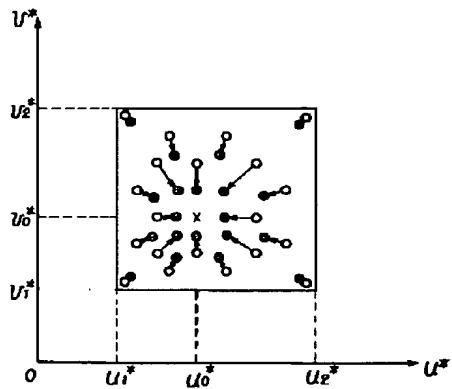
【図1】



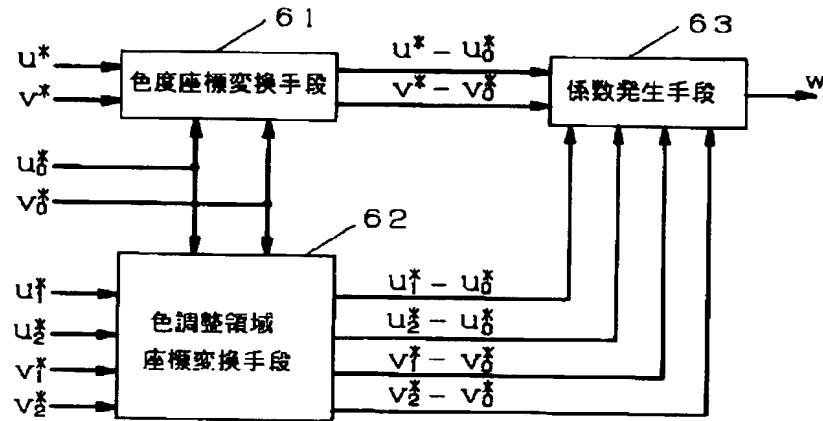
【図12】



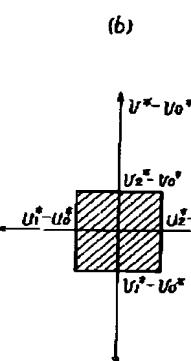
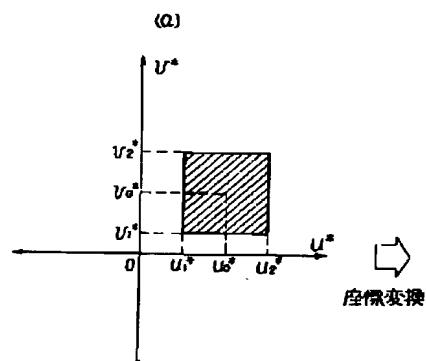
【図8】



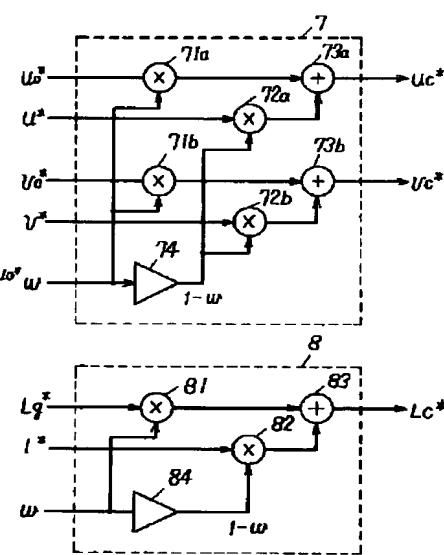
【図2】



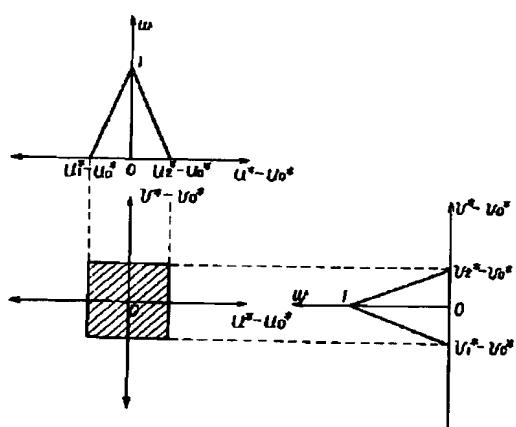
【図3】



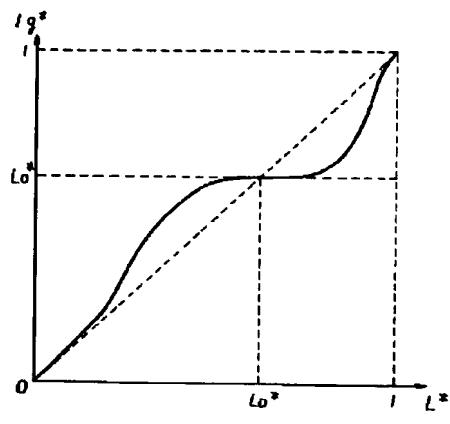
【図5】



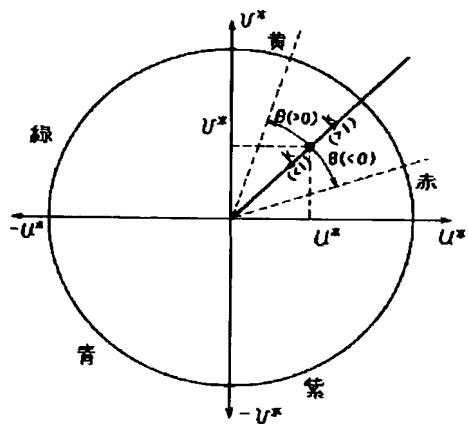
【図4】



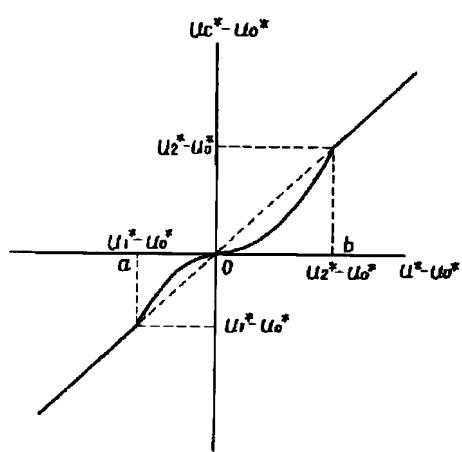
【図6】



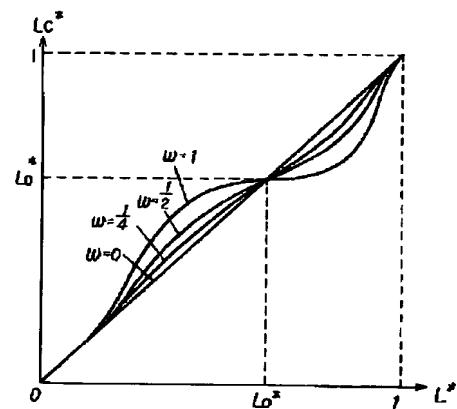
【図7】



【図9】



【図10】



【図11】

